

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 1 213 054 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.06.2002 Bulletin 2002/24

(51) Int Cl. 7: B02C 9/04

(21) Application number: 01307803.5

(22) Date of filing: 13.09.2001

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR

Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 13.09.2000 US 661139
13.09.2000 US 661136

(71) Applicant: THE QUAKER OATS COMPANY
Chicago, Illinois 60610-4714 (US)

(72) Inventors:

- Griebat, John
Atchison, KS 66002 (US)
- Strief, David
Palo, IA 52324 (US)

(74) Representative: Schlich, George William et al
Mathys & Squire
European Patent Attorneys,
100 Gray's Inn Road
London WC1X 8AL (GB)

(54) Process for milling corn

(57) The present invention is a short flow milling process wherein finished product is rapidly isolated and removed from the milling process flow regime at early stages. The minimization of handling and the minimization or elimination of intermixing streams of various size gradations prevents size contamination that otherwise necessitates further sifting. Component parts are eliminated along with the accompanying handling and transfer equipment to create a compact and highly efficient milling regime.

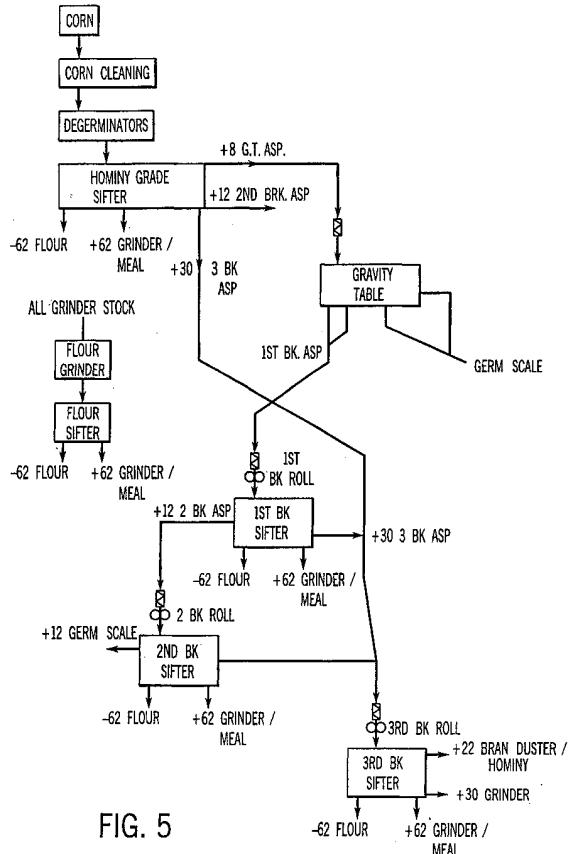


FIG. 5

Description

[0001] The present invention relates to processes for milling corn (maize) and obtaining products such as flour and meal therefrom.

5 **[0002]** The corn kernel is a staple crop grown in many parts of the world. Corn is also known as Indian corn or maize and the flour, meal and oil obtained from corn are used as ingredients in many food products. Corn milling is an ancient practice to the human race. Historically, mill stones were utilized to grind the corn into meal. Wind and water powered mills developed several hundred years ago allowed for increased efficiency in the processing of corn. For the past hundred years, milling operations have typically utilized roll milling equipment in an effort to separate the components 10 of the corn kernel for more particularized uses.

15 **[0003]** The corn kernel, as illustrated in Fig. 1, has a number of components, each being best suited for various uses. The process of modern dry corn milling seeks to segregate and separately process the below-identified parts of a kernel of corn as each part has a separate use. The hard outer shell is called the pericarp or the bran coat. The end of the corn kernel which adheres it to the corn cob is called the tip cap. The interior of the corn kernel consists of the 20 endosperm and the germ. The endosperm is generally broken into two parts: soft endosperm and hard endosperm. For purposes of human consumption, the hard endosperm generally produces grits and corn meal, and the soft endosperm generally produces corn flour. The germ contains a much higher percentage of fat compared to the other parts of the kernel and is the source of corn oil.

25 **[0004]** Modern roll milling equipment utilizes contiguous rollers with varying sized corrugations and varying sized roller gap spacings to achieve the desired particle size fractionation. Typically, mills employ rollers in series with increasingly narrow gaps in a gradual milling process. More specifically, the various parts of the corn kernel are segregated and removed to differing processing pathways, often referred to as streams. Initially, after cleaning the hard outer shell, the kernel is fractured via a mechanical process thereby freeing and removing the germ from the remaining parts 30 of the kernel-a step called degermination. The remaining parts of the kernel are broken up by a series of rollers. As this material is processed, the hard outer shell (bran) flakes are removed and the remaining soft and hard endosperm are further processed into differing streams by passing through a series of rollers and sifters which separate product by particle size. The end products of the dry corn milling operation are bran, grits, meal, flour, and high fat germ.

35 **[0005]** A flow scheme typical of prior art mills is illustrated in U.S. Patent No. 5,250,313. In Figure 5, of the '313 patent (reproduced herein as Figure 2), the incoming corn is cleaned, washed, tempered to the appropriate moisture content, fractured or degerminated, and dried. Various designs exist to carry out the step of degermination. For example, the Ocrim degerminator uses a spinning rotor having combination blades to operate against a horizontal, perforated cylinder that only allows partial kernels to pass. The rotor and breaker bars are set to break the corn against a spiral rotor bar and a cutting bar. Another known degerminator is the Beall degerminator. In the Beall degerminator, grinding occurs through an abrasive action of kernel against kernel, and kernel against a nested conical surface and screen. Impact-type degerminators are also used. An example is the Entoletor degerminator as illustrated in Fig. 3. The Entoletor includes a vertical drive shaft that operates a rotor. Kernels are fed downwardly towards the rotor where they are forced outwardly by centrifugal motion to impact a liner surface.

40 **[0006]** Generally, the product out of the degerminator is separated into a first stream which is relatively rich in endosperm and a second stream which is relatively rich in germ and bran. Specifically, with reference again to Fig. 2, the degerminated corn is aspirated to effect initial density separation of the fractured kernel. The tailings and liftings from the aspirators are further separated through additional aspiration or the use of gravity tables. In general, bran, whole 45 germ and germ contaminated particles obtained via density separation are lighter than other constituent parts and may be partially removed via gravity separation to be directed through a series of germ rollers and sifters. Separated, primarily endosperm-containing streams from the gravity tables and aspirators may be directed to different break rollers depending on the particle size of the stream. For example, those primarily endosperm-containing streams having smaller particle sizes may be directed past the first and second break rollers, or as illustrated in Fig. 2, beyond to later break rollers.

50 **[0007]** The "break rollers" used in a gradual break process typically comprise corrugated rollers having roller gaps that cascade from wider roller gaps for the 1st break roller to more narrow roller gaps for subsequent break rollers. Roller gaps are the spacings between the exterior or "tip" portions of the corrugations on opposing rollers. The use of five break rollers is typical, and roller gaps may vary depending on the desired finished product. Typical roller gap distances on prior art systems range from about 0.25 mm (0.01 inches) to about 1.8 mm (0.07 inches), wherein smaller gaps result in finer particles. In general, the break rollers are operated such that opposing corrugated roller faces rotate at differing rates. Figure 4 contains examples of typical prior art roller corrugation configurations. Most configurations present a sharp edge and a dull edge as determined by the slope of the corrugation surface. Therefore, breaking may occur under a sharp to sharp, sharp to dull, dull to sharp, or dull to dull arrangement of opposing corrugations.

55 **[0008]** After break rolling, the further-broken particles are separated, typically by a sifting process. From there, larger particles are further rolled in a subsequent break roller (and the further-broken particles are again sifted), or they are

passed on to drying or cooling steps or additional sifting steps to isolate finished products (flour, meal, grits, etc.). Of course other products may be desired by particular purchasers. The remaining particles that fail to pass the post germ sifting steps are typically sent to a germ handling process (labeled oil recovery in Figure 2). The finer particles obtained from the germ roller siftings are processed in a manner generally similar to the finer particles from the break rollers.

[0009] Traditionally, large scale corn mills have employed a great degree of redundancy and repetitive processing of the grain. For example, as illustrated in Fig. 2, a traditional corn milling process involves an initial degeneration step, followed by five separate roller, or breaking, steps each of which is followed by sifting steps. In addition, the prior art includes various shorter mill processes wherein fewer roller steps are utilized, germ streams are extracted from the mill stream earlier in the process, and valuable capital, space and time savings are achieved. See for example the process described in the '313 patent. The shortened mill regimes also dramatically reduce production expense by lowering the labor costs associated with the milling process due to the reduced maintenance and monitoring required of a much shorter process.

[0010] Nevertheless, even in the prior art "shortened" mill flow regimes, inefficiencies remain. For example, U.S. Patent No 4,189,503 (a parent from which the '313 patent is a continuation-in-part), teaches the use of a preferred degeneration and rolling process to avoid breakage of the germ. These patents also teach the separation of degeneration products into three streams, one of which is a "fine" stream relative to the others (see Figures 6, 7, and 8 of the '313 patent and accompanying text). The '313 and '503 patents specifically teach the reintroduction of this fine stream into the other less carefully graded streams after the other streams have been subjected to various other steps, such as tempering and drying (See Claim 8 of the '503 patent). The '313 and '503 patents therefore specifically teach the separation or gradation of post degeneration product for the purpose of avoiding the addition of moisture to the separated fines (See '313 patent, Col. 11, Lines 4-14) followed by the subsequent reintroduction of the fine stream into a mixed stream. In fact, the '313 patent teaches a process wherein the product stream from the degenerator to the first break roll comprises bran, endosperm and germ. In addition, the reintroduction of the sifted "fines" streams into other streams "contaminates" the sifted stream and increase the flow across subsequent sifters.

[0011] It is an object of the present invention to provide an improved process for milling corn. In particular, it is an object to provide a milling process of greater efficiency and requiring a reduced amount of processing equipment without loss of yield compared to prior art processes.

[0012] Accordingly a first aspect of the invention provides a method for processing grain kernels, such as corn, to obtain a desired finished product comprising the steps of:

- 30 a. cleaning the kernels of grain;
- b. degenerating the cleaned kernels of grain;
- c. sorting the degenerated kernels of grain into selected size classes;
- d. removing at least one of said size classes as a desired end product to a first location; and
- e. diverting the remaining size classes to one or more other locations.

[0013] In a preferred embodiment of the invention, the method further comprising the steps of:

- 40 diverting one or more of the remaining size classes to a germ oil recovery process; and/or
- diverting one or more of the remaining size classes of corn to an aspirator and aspirating said size class of corn;
- diverting the aspirated corn to a roller.

[0014] A second aspect of the invention provides a method of milling grain kernels, comprising:

- 45 a. breaking the kernels into pieces in a first breaking step;
- b. at least partially sorting the pieces into streams of different sized pieces;
- c. extracting at least one of the streams as a finished product stream; and
- d. breaking the pieces in the remaining streams in at least a second breaking step.

[0015] A third aspect of the invention provides a method of milling grain kernels, comprising:

- a. breaking the kernels into pieces in a first breaking step;
- b. at least partially sorting the pieces into first streams of different sized pieces;
- c. extracting at least one of the first streams as a finished product stream;
- 55 d. breaking the pieces in the remaining first streams in at least a second breaking step and at least partially sorting the pieces into second streams of different sized pieces;
- e. extracting at least one of the second streams as a finished product stream; and optionally
- f. further breaking the pieces in the remaining second streams in at least a third breaking step.

[0016] It is preferred that the grain is corn, namely Indian corn or maize.

[0017] Typically in the methods of the invention the first breaking step is a degermination step. Suitable degerminators include impact degerminators, Entoletor degerminators, Ocrim degerminators, or Beall degerminator. The method of operation of these degerminators is given above.

5 [0018] In an embodiment of the invention described in more detail below the methods comprise up to four concurrent and/or consecutive breaking steps, made up of one degermination step and three breakage steps. Some of the broken kernel pieces will pass through more than one breakage step before reaching the desired end product size, whereas other pieces may be removed as finished product after only the first or second breaking steps.

10 [0019] Typically, the second and any subsequent breaking steps utilize break rollers, which rollers are preferably corrugated rollers. After the breakage steps sorting of the broken kernel pieces is suitably achieved by use of a sifter, a hominy grader, a gravity table and/or an aspirator.

[0020] It is desirable for the finished product stream to comprise broken kernel pieces of substantially homogeneous size and grades - i.e. flour, meal, bran, grits or high fat germ.

15 [0021] A further aspect of the invention, provides a method for processing kernels of corn to produce a desired finished product comprising the steps of:

- cleaning the kernels of corn;
- breaking the kernels of corn into two or more parts;
- separating the parts according to selected size classes;
- removing at least one of said size classes as the finished product.

[0022] In further aspects of the invention methods for providing grain milling services are provided comprising the steps of:

25 transporting a short flow grain milling process to a location;
 receiving grain into the short flow grain milling process;
 generating a finished product from said short flow grain milling process.

[0023] A further aspect provides a preferred method of the invention comprising the steps of:

30 transporting a short flow grain milling process comprising a cleaner, a degerminator, a first sifter, at least one roller, and a second sifter;
 processing grain to produce a selected finished product using said short flow grain milling process wherein at least a portion of the selected finished product is obtained directly from the first sifter.

35 [0024] Any of the short flow grain milling processes of the invention may be suitably transported according to these aspects of the invention. In specific embodiments of the invention the short flow grain milling process is transported via truck, train, airborne transport and/or waterborne transport.

[0025] The present invention is an improvement upon the prior art in that the present process does not contaminate 40 or intermix the separated streams with less specifically graded streams once the finished product stream has been isolated. This is of significant advantage as it results in a dramatic decrease in handling and a reduction or elimination of flow across subsequent process steps. The resultant increase in the through-put of product allows for the processing of an increased volume of corn in a given time, as well as the elimination of excess processing equipment.

[0026] The processes taught in the '313 and '503 patents contrast with that of the present invention by providing the 45 contamination of the initially separated fine stream. With only a reference to fines, these patents do not teach or provide motivation to isolate finished product streams as early in the milling process as a post degermination sifting. This is different to the process of the present invention where a sifted end-product-grade stream is obtained from the initial degermination sifting or grading step and is directed towards storage or finished product handling (storage, packaging, quality control, etc.). If mixing of this stream occurs, it involves the blending of similarly sifted streams having particles of the same gradations, i.e., addition of a similar finished product stream.

[0027] The present invention utilizes a short flow corn mill having a dramatically reduced number of process steps with a commensurate reduction in processing and handling equipment, process monitoring and maintenance labour costs, and process space requirements. This mill design utilizes fewer, but more aggressive break subsystems, instead of five gradual break subsystems, to appropriately shorten the flow while providing exceptional quality and yield performance.

[0028] The present invention typically employs zero to three break rollers in series (or more if parallel operations or redundancies are desired for system stability, etc) and preferably from one to three break rollers.

[0029] Finished product grade material is withdrawn from process streams when it is first separated, without further

intermixing of already separated streams and without a need for further production sifting. This separation occurs early in the short mill process, preferably as early as separation of the degermination stream.

[0030] In addition, one embodiment of the present invention includes the diversion of other streams at early points in the milling process to a separate hammer-mill process for the production of flour. This diversion of product to a hammer-mill process additionally eliminates product from the stream and further reduces the amount of handling, intermixing, and possible contamination of already separated streams with product of different gradations. Further, these diversions reduce the flow on rollers and on later portions of the mill. Therefore, efficiency is achieved by the rapid isolation and removal of finished product from the stream. Further, yield as well as efficiency is improved.

[0031] Average corn milling yields for the industry are 100 units of finished product per 180 units of raw corn starting material. The short flow milling technology of the present invention allows for a dramatically improved yield of 100 units of finished product per 129 units of raw corn, which is currently the best yield in the industry (it is believed that the industry best has been 100/135 prior to the new short flow technology of the invention).

[0032] The dramatic elimination of components and the accompanying conduits and transport equipment needed to combine such components, from as many as 450 machines to produce 118,181 kg/hr (260,000 lbs/hr) in known prior art large scale mill processes to fewer than 85 machines to produce 72,727 kg/hr (160,000 lbs/hr), allows for tremendous space savings.

[0033] In addition, monitoring and maintenance needs can be greatly reduced with the short flow process.

[0034] The process of the invention is illustrated by the accompanying drawings in which,

- 20 Fig. 1 is an enlarged diagram of a kernel of corn (maize) to display the constituent portions of the kernel;
- Fig. 2 is a flowchart of a typical prior art gradual break milling process;
- Fig. 3 is a front elevational view of a prior art Entoleter impact degerminator;
- Fig. 4 is an illustration of prior art break roller corrugations;
- Fig. 5 is a block diagram of the flow in a first preferred embodiment;
- Fig. 6 is a block diagram of the flow in a second preferred embodiment.

[0035] In the present invention, kernels are received and the kernels may, optionally, be pre-treated in any manner required to maximize the production of the desired end product (grits, meal, flour, etc.). For example, the corn is most commonly cleaned through impact de-infestation or washing. The choice of a cleaning method will depend upon the desired end product, as even the cleaning steps may result in breakage of kernels or an alteration in the moisture content. Additionally, pre-treatment may involve tempering or moisturizing of the corn with water, hot water and/or steam, although this is not necessary.

[0036] Because the corn kernel's constituent parts, as illustrated in Fig. 1 and as discussed above, comprise separate components of distinct character, each absorbs moisture differently and this differential absorption impacts degermination efficacy. For example, the pericarp or bran coat may be brittle without tempering, but tempering creates a more pliable bran coat that is more likely to be removed intact or as a particle of larger size. Similarly, tempering may aid the release of the germ still in connection with the tip-cap. This allows the removal of the tip cap with the germ and a reduction in the number of black tip-caps that may be further milled and result in discoloration of the finished product. In fact, the '313 patent teaches tempering as a method for the facilitating the shortened process. However, tempering necessarily increases production costs through energy expense for drying, and as a result tempering is not necessary to practice the process of the present invention.

[0037] After cleaning, and the optional and/or desired pre-treatment, the corn is degerminated. In the currently preferred embodiment, the corn is degermed without the use of tempering and is accomplished with an impact degerminator. This preferred method of degermination typically achieves breakage of the kernel into relatively large pieces, dislodging the germ. Degermination is followed by a separation step. Degermination may be followed by a drying step prior to separation if tempering is elected, or drying may occur at a later stage in the process.

[0038] The post-degermination sifter is herein referred to as a "hominy grader." The hominy grader segments the broken corn into various streams depending on granulation-the size of the product granules. The finer granulated streams, such as low fat meal and flour streams are directed as finished product from the hominy grader to eliminate excessive handling and deterioration of product quality. Optionally, the meal stock may be directed towards a hammer-mill or flour grinder if greater flour output is desired. By extracting finished product as soon as possible, the mill flow can be greatly reduced as further sifting of an already isolated stream is not required.

[0039] The medium granulated streams from the hominy grader are sent to directly to aggressive 2nd and 3rd (in series) break roll subsystems via aspirators. When sent directly to the 2nd break roll subsystem, the stream does not pass first through the 1st break roll subsystem. When sent directly to the 3rd break roll subsystem, the stream does not pass first through either the 1st or 2nd break roll subsystems. Therefore, the present invention allows for the processing of a greater volume without increasing a greater load on a particular roller. The aspiration step helps to break apart combined particles and further separate any remaining bran, germ or other non-endosperm material from the en-

dosperm material. Preferred aspirators comprise cascading angled surfaces having periodic ports in the sidewalls to allow a cross stream of air to "blow" loosened bran from the falling particles. The liftings removed via aspiration can be directed to bran processing as a high value input.

[0040] The coarse granulated streams from the hominy grader are sent to gravity tables via aspiration. From the gravity tables, a lighter germ and germ-contaminated stream can be directed onward to an oil or germ recovery process. The remaining portions of the coarse product stream are sent to the aggressive 1st break roll (in series) via aspiration.

[0041] No whole corn kernels that reach these later stages are resent to degermination since the degerminator is effectively breaking the corn in one step. From each sifting step, including the hominy grader and the post 1st, 2nd, and 3rd break siftings, finished product flour and meal are isolated and removed from the mill stream.

[0042] With specific reference to Figure 5, a first preferred embodiment of the present invention operates as follows. The input corn is cleaned and degerminated prior to arrival at the hominy grader. In the hominy grader, a number 6, 12, 30, and 62 wire mesh screen is employed to separate the particles from degermination. Alternative screen sizes may be employed to produce finished product having the desired particle size profiles and ranges. The overs (particles that do not pass through) the number 6 screen are directed towards a gravity table via aspiration. From the gravity table, the lighter germ and germ contaminated material is removed and directed to a germ or oil recovery process. It has been found that at or above 95% of the germ is removed from the process stream at this point.

[0043] The heavier particles from the gravity table are directed to a first break roller. The overs from the number 12 screen of the hominy grader are directed towards a second break roller via aspiration. The overs from the number 30 screen of the hominy grader are directed towards a third break roller via aspiration. Finally, the overs from the number 62 screen of the hominy grader are directed onward as finished product meal, whereas those portions that pass the number 62 screen are directed onward as finished product flour. Upon inspection, typically based on fat content, the meal finished product stream can optionally be diverted for grinding in to flour.

[0044] Although the present invention is described with reference to a sharp meal obtained between number 30 and number 62 wire screens, meal may be classified or obtained from other ranges as is known to those in the art. For example, a meal top screen typically ranges from about a number 30 to about a 46 and a meal bottom screen typically ranges from about a 46 to about a 72. Similarly flour can be that portion that passes screens ranging from about a number 46 screen to about a number 72 screen. Therefore, although specific number wire mesh screens are referenced herein to describe the preferred embodiments, it is understood that the present invention may be practiced to achieve alternate finished product particle profiles.

[0045] The first break roller typically employs rollers having approximately 6 corrugations per cm (equivalent to 14 corrugations per inch) with a dull to dull arrangement. The roller distance is typically adjusted after production begins. These adjustments allow operators to achieve target percentages for the differently sized particles coming off the rollers - i.e., the percentage of the roller output that falls into each screen size in the post-roller sifting step. It will be appreciated by the skilled person, however, that the corrugations, roller set-up and product output goals disclosed herein are preferred embodiments and that the present invention can be modified to maximize the overall mill output of a variety of particular product streams (meal, flour, grits etc.).

[0046] From the first break roller, rolled particles are sifted with a number 12, 30 and 62 wire mesh screen. Flour and meal are removed as finished product from the milling stream, as before. The overs from the number 12 screen are sent to the second break aspirator (along with the overs from the number 12 screen of the hominy grader), and the overs of the number 30 screen are sent to the third break aspirator.

[0047] The second break rollers typically employ 6 corrugations per cm (equivalent to 14 corrugations per inch), and a dull to dull configuration. From the second break roller, rolled particles are sifted with a number 12, 30 and 62 wire mesh screen. Flour and meal are removed as finished product from the milling stream, as before. The overs from the number 12 screen are sent to the germ or oil recovery, and the overs of the number 30 screen are sent to the third break aspirator. Removal of the largest remaining particles from this step to oil recovery and germ processing further reduces the milling stream and limits the fat content of the remaining product.

[0048] The third break rollers employ approximately 8 corrugations per cm (equivalent to 20 corrugations per inch), a dull to dull configuration. From the third break roller, rolled particles are sifted with a number 22, 30, and 62 wire mesh screen. Flour and meal are removed as finished product, as before. Overs from the 30 screen are directed to grinding, such as a hammer mill process to produce flour. Overs from the 22 screen are directed towards a bran dusting step to abrade remaining bran. The bran recovered from the bran duster is suitable to be used as a bran flour or in other bran product process. The remains from the bran dusting process may, if desired be directed to re-enter the process at the hominy grader.

[0049] All grinder stock (including the overs from the number 30 screen of the third break sifter and some or all finished product meal if meal production is not desired) is ground, through a process such as hammer milling to generate flour. Simple sifting with a flour screen (here a 62 wire screen) may be used to isolate additional finished product flour and redirect the overs of the flour screen for additional grinding. Throughout the process disclosed in Fig. 5, at sifting steps in particular, additional screens can be included. This adds the advantage of further separating streams with

potentially valuable uses.

[0050] In another preferred embodiment, illustrated in Fig. 6, the streams from the gravity table separator are further divided to include diversion to a gravity table germ aspirator. From the gravity table germ aspirator, product is directed to a gravity table germ roller and sifter. The gravity table germ roller preferably employs approximately 5 corrugations per cm (equivalent to 12 corrugations per inch). The gravity table germ roller sifter employs a number 12, 30 and 62 wire mesh screen. Flour and meal finished products are directed onward as before. The overs of the number 12 screen are directed to germ or oil recovery processing, and the overs of the number 30 screen are directed onward to third break rollers via aspiration.

[0051] It has been found that the preferred embodiment described in Fig. 6 is capable of producing meal and flour in accordance with the data shown in Table 1 below. Further, Table 2 illustrates the percentage of product obtained from the various sifting steps.

[0052] It will be apparent to those skilled in the art that the short flow design of the present invention provides a finished product much faster in the milling process than typical full scale milling operations (hominy grader vs. 1st or 2nd break sifter). Each break sifter on the short flow produces finished product as contrasted with typical milling methods where secondary handling and sifting are required.

[0053] Further, intermediate product streams are reduced to flour unlike other systems which use germ, tailings and purifier subsystems to reclaim poorer quality meal streams. This provides very high quality meal/flour with minimal equipment, reduced monitoring and maintenance needs, and superior yield performance. The basic milling philosophy behind the development of a shorter corn milling flow is to produce finished product faster, cheaper and better. This and the other objectives of the present invention are achieved through the application of the preferred mode and the invention as claimed herein.

[0054] Of course, these benefits make possible the method of the present invention for easily transportable, on-site milling applications. Simply put, when the process may be simplified to eliminate redundancy in rolling and sifting, eliminate steps required to attain a finished product, and reduce monitoring and maintenance needs, the milling process can be taken from an isolated production facility and milling may be instituted on location - for example in a mobile milling facility capable of traveling to the source of the starting material.

TABLE 1

ROLLER SETTING DATA					
Roll	Corrugations/cm	Roll Set Up	Prod Distribution Target		Prod Distribution Target
1 st Break	6/cm	Dull to Dull	7% + 12 mesh		9% max + 12 mesh
GTG	5/cm	Dull to Dull	20% + 12 mesh		22% max + 12 mesh
2 nd Break	6/cm	Dull to Dull	8% + 12 mesh		10% max + 12 mesh
3 rd Break	8/cm	Dull to Dull	3% + 22 mesh		5% max + 22 mesh

TABLE 2

HOMINY GRADER SIFTER 11350 KG/HR HEAD FEED						
Meal	Wires	Meal Sieving		Flour		
		%				
Fat	1.40%	+ 20	Trace	Fat	1.17%	
Moist	11.70%	+25	1.14%	Moist	12.56%	
		-70	1.00%			
1 ST BREAK SIFTER DISTRIBUTION 2951 KG/HR HEAD FEED						
Meal	Wires	Meal Sieving		Flour		
		%				
Fat	1.12%	+20	Trace	Fat	0.98%	
Moist	10.80%	+25	0.71%	Moist	13.50%	
		-70	0.85%			

TABLE 2 (continued)

GT GERM SIFTER DISTRIBUTION 2634 KG/HR HEAD FEED						
5	Meal	Meal Sieving		Flour		
		Wires	%			
10	Fat Moist	3.51% 13.26%	+20 +25 -70	Trace 0.86% 0.22%	Fat Moist	2.26% 12.70%
2 ND BREAK SIFTER DISTRIBUTION 3905 KG/HR HEAD FEED						
15	Meal	Meal Sieving		Flour		
		Wires	%			
20	Fat Moist	1.33% 13.55%	+20 +25 -70	Trace 1.54% 0.34%	Fat Moist	1.49% 13.12%
3 RD BREAK SIFTER DISTRIBUTION 6901 KG/HR HEAD FEED						
25	Meal	Meal Sieving				
		Wires	%			
	Fat Moist	1.22% 13.10%	+ 20 +25 -70	Trace 0.70% 0.02%		

Claims

30 1. A method for processing grain kernels to obtain a desired finished product comprising the steps of:

- cleaning the kernels of grain;
- degerminating the cleaned kernels of grain;
- sorting the degenerated kernels of grain into selected size classes;
- removing at least one of said size classes as a desired end product to a first location; and
- diverting the remaining size classes to one or more other locations.

2. A method of milling grain kernels, comprising:

- breaking the kernels into pieces in a first breaking step;
- at least partially sorting the pieces into streams of different sized pieces;
- extracting at least one of the streams as a finished product stream; and
- breaking the pieces in the remaining streams in at least a second breaking step.

45 3. A method of milling grain kernels, comprising:

- breaking the kernels into pieces in a first breaking step;
- at least partially sorting the pieces into first streams of different sized pieces;
- extracting at least one of the first streams as a finished product stream;
- breaking the pieces in the remaining first streams in at least a second breaking step and at least partially sorting the pieces into second streams of different sized pieces;
- extracting at least one of the second streams as a finished product stream; and optionally
- further breaking the pieces in the remaining second streams in at least a third breaking step.

55 4. A method according to any of claims 2 and 3 wherein the first breaking step is a degeneration step.

5. A method according to claims 1 or 4, wherein the degenerator is an impact degenerator, an Entoleter degenerator, an Ocrim degenerator, or a Beall degenerator.

6. A method according to any of claims 2-5 comprising up to four breaking steps.
7. A method according to claims 2-6 wherein said at least second and any subsequent breaking steps utilize break rollers.
- 5
8. A method according to claim 7 wherein said break rollers employ corrugated rollers.
9. A method according to any previous claim wherein the sorting is achieved by use of a sifter, a hominy grader, a gravity table and/or an aspirator.
- 10
10. A method according to any previous claim wherein the product comprises pieces of substantially homogeneous size.
11. A method according to claim 10 wherein the product comprises flour.
- 15
12. A method according to claim 10 wherein the product comprises meal.
13. A method according to claim 10 wherein the product comprises bran.
- 20
14. A method according to claim 10 wherein the product comprises grits.
15. A method according to claim 10 wherein the product comprises high fat germ.
16. A method according to any previous claim wherein the grain is corn.
- 25
17. The method according to claim 1 further comprising the steps of:
 - diverting one or more of the remaining size classes to a germ oil recovery process; and/or
 - diverting one or more of the remaining size classes of corn to an aspirator and aspirating said size class of corn;
 - 30
 - diverting the aspirated corn to a roller.
18. A method according to any previous claim wherein the grain is not tempered.
19. A method for processing kernels of corn to produce a desired finished product comprising the steps of:
 - 35
 - cleaning the kernels of corn;
 - breaking the kernels of corn into two or more parts;
 - separating the parts according to selected size classes;
 - removing at least one of said size classes as the finished product.
- 40
20. A method for providing grain milling services comprising the steps of:
 - transporting a short flow grain milling process to a location;
 - 45
 - receiving grain into the short flow grain milling process;
 - generating a finished product from said short flow grain milling process.
21. A method for milling corn comprising the steps of:
 - 50
 - transporting a short flow grain milling process comprising a cleaner, a degerminator, a first sifter, at least one roller, and a second sifter;
 - processing grain to produce a selected finished product using said short flow grain milling process wherein at least a portion of the selected finished product is obtained directly from the first sifter.
- 55
22. A method according to any of claims 20-21 wherein the short flow grain milling process is the method of any of claims 1-19.
23. A method according to claims 20-22 wherein the short flow grain milling process is transported via truck, train, airborne transport and/or waterborne transport.

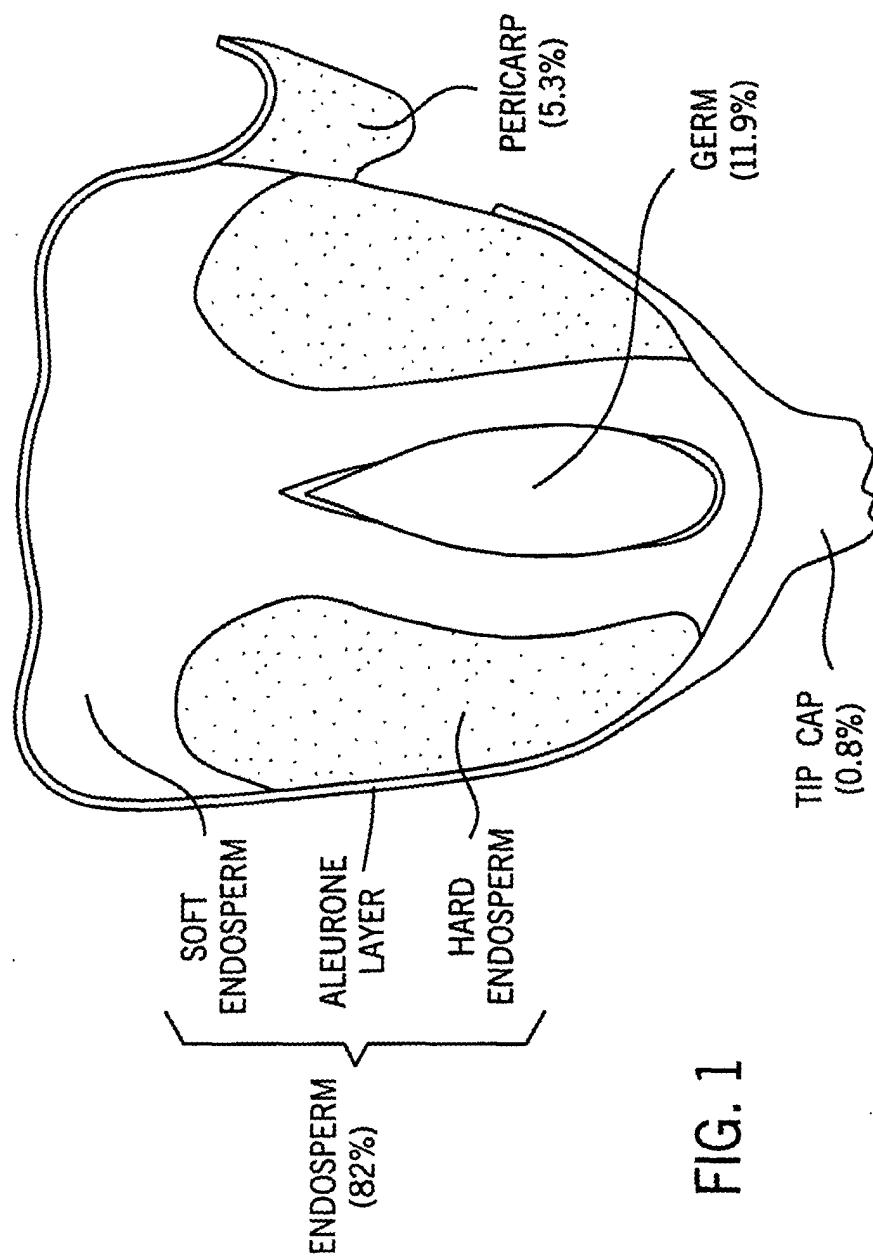


FIG. 1

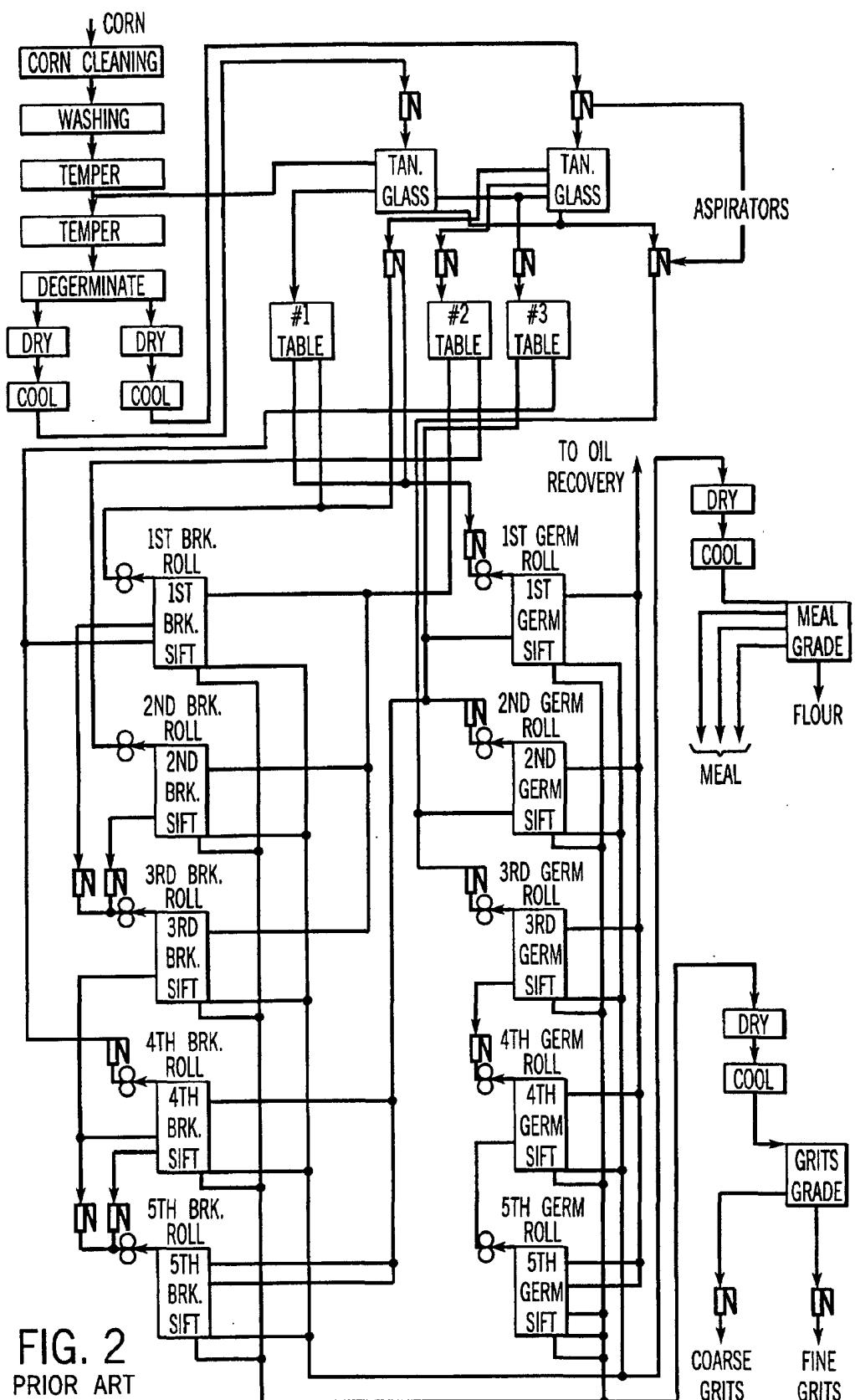
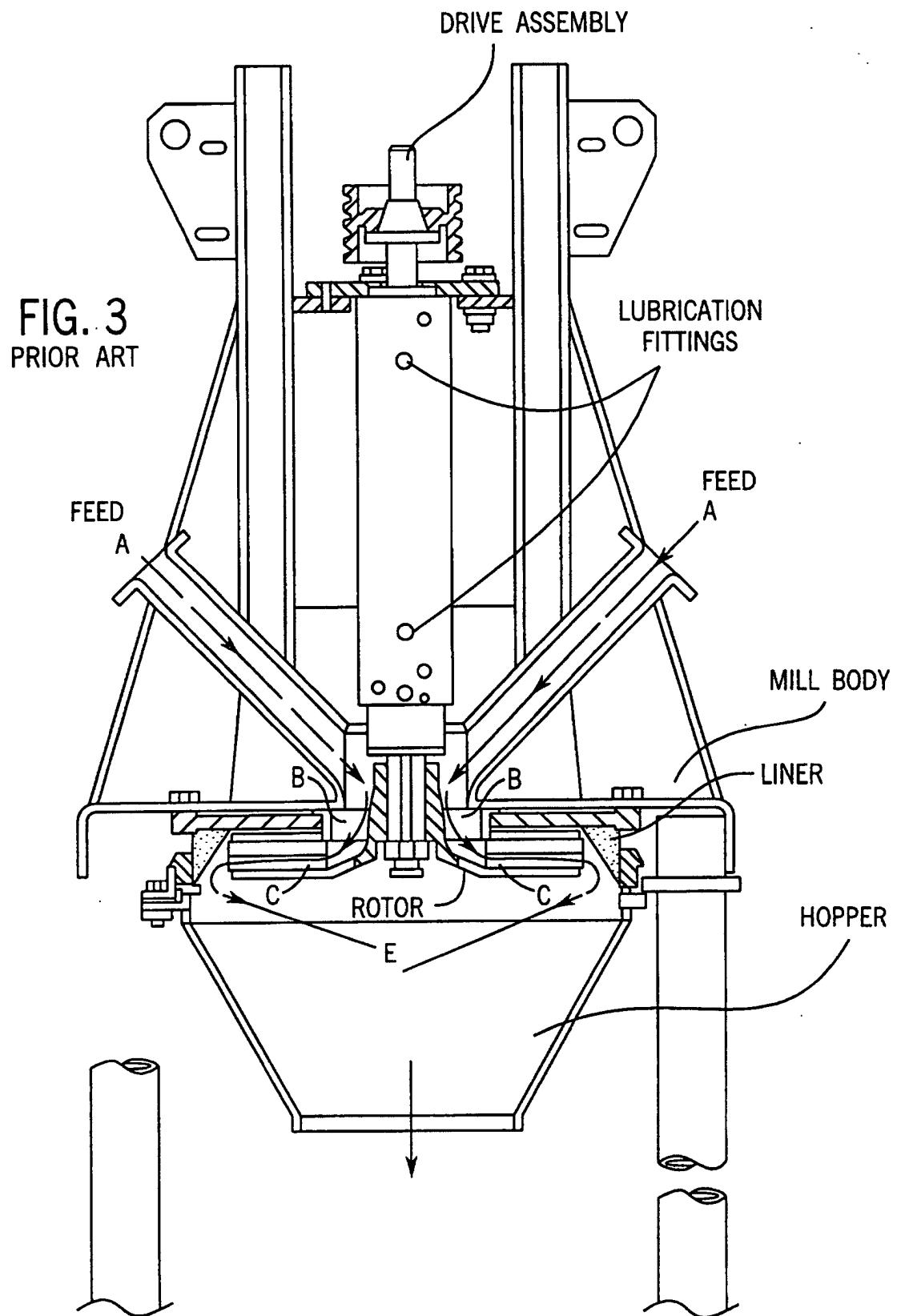


FIG. 2
PRIOR ART



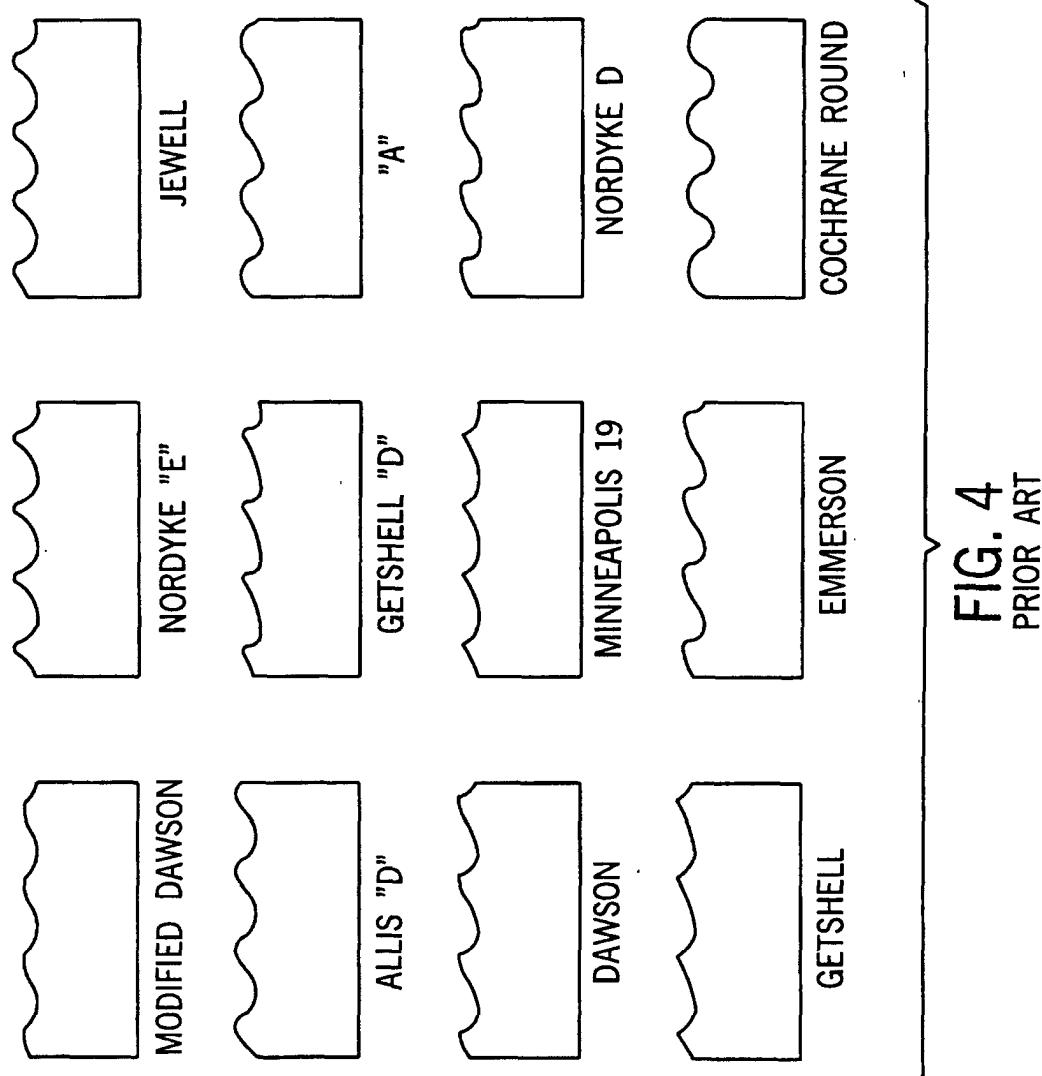


FIG. 4
PRIOR ART

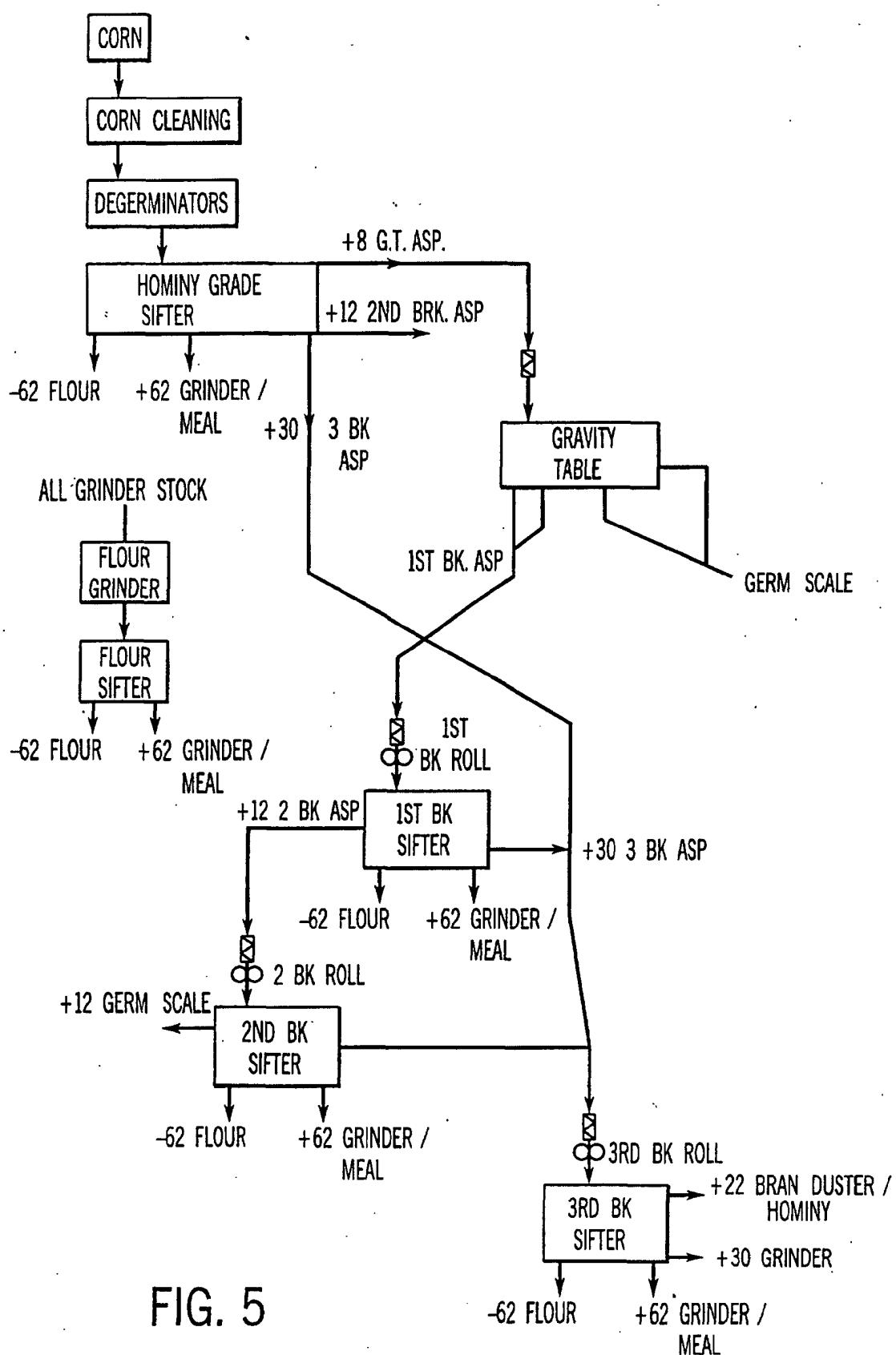


FIG. 5

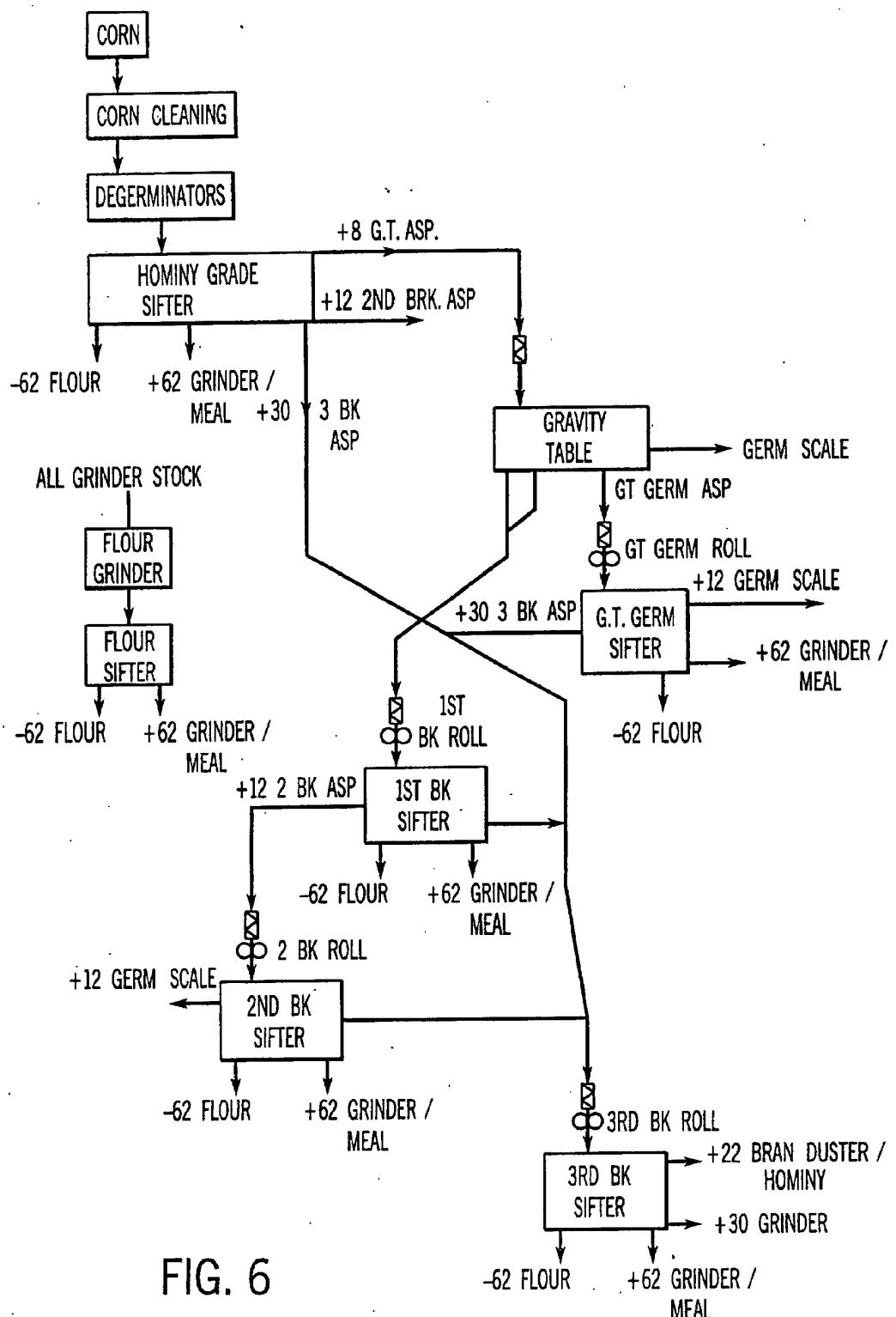


FIG. 6



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 30 7803

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 2 460 389 A (LLOYD WILLIAM R ET AL) 1 February 1949 (1949-02-01) * column 3, line 27 – line 67; claim 1; figure 1 *	1,2,4, 6-10,12, 14-16,19	B02C9/04
Y	---	5,22 21	
X	EP 0 418 801 A (T P T TECHNOLOGIES S P A) 27 March 1991 (1991-03-27) * column 4, line 37 – column 5, line 47; figure 1 *	2,3, 9-11,13, 16,19	
Y	---	22 1,21	
X	EP 0 958 863 A (SATAKE ENG CO LTD) 24 November 1999 (1999-11-24) * page 2, line 19 – line 39; figures 1,2 *	2,3, 9-11,19	
Y	---	22 20	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
X	AT 380 183 B (DYK PETER) 25 April 1986 (1986-04-25) * page 3, line 30 – page 4, line 18; figure 1 *	2,3,6,9, 10,12,18	B02C B02B
Y	---	22	
X	DE 37 10 602 A (MALOMIPARI KUTATO INTEZET) 12 November 1987 (1987-11-12) * column 4, line 11 – column 5, line 64; figures 1-3 *	2,3,6,7, 9,10,12	
Y	---	22	
		-/--	
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
THE HAGUE	28 November 2001	Verdonck, J	
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone	T : theory or principle underlying the invention		
Y : particularly relevant if combined with another document of the same category	E : earlier patent document, but published on, or after the filing date		
A : technological background	D : document cited in the application		
O : non-written disclosure	L : document cited for other reasons		
P : intermediate document	& : member of the same patent family, corresponding document		



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 30 7803

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int.Cl.7)		
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)		
X	US 5 114 079 A (CURRAN STEVEN P) 19 May 1992 (1992-05-19) * column 4, line 10 - column 5, line 21; figure 1 *	2,7-11, 13,20			
Y	---	22			
X	CH 271 100 A (HAAB WERNER) 15 October 1950 (1950-10-15) * page 2, line 93 - page 3, line 33; figures 1-4 *	20,23			
Y	---	22			
Y	US 2 108 655 A (CLAY DEMPSEY HENRY) 15 February 1938 (1938-02-15) * page 1, left-hand column, line 1 - line 10; figure 1 *	5			
A,D	US 5 250 313 A (GIGUERE R JAMES) 5 October 1993 (1993-10-05) * the whole document *	1-5,9, 10,12, 14,16, 17,19-21	TECHNICAL FIELDS SEARCHED (Int.Cl.7)		
The present search report has been drawn up for all claims					
Place of search	Date of completion of the search		Examiner		
THE HAGUE	28 November 2001		Verdonck, J		
CATEGORY OF CITED DOCUMENTS					
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background D : non-written disclosure P : intermediate document					
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document					

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 01 30 7803

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

28-11-2001

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
US 2460389	A	01-02-1949	NONE		
EP 0418801	A	27-03-1991	IT EP JP	1232673 B 0418801 A1 3135448 A	02-03-1992 27-03-1991 10-06-1991
EP 0958863	A	24-11-1999	JP AU BR CN EP TW US	2000033276 A 2252899 A 9901538 A 1238242 A 0958863 A1 398996 B 6199777 B1	02-02-2000 25-11-1999 18-01-2000 15-12-1999 24-11-1999 21-07-2000 13-03-2001
AT 380183	B	25-04-1986	AT AT	380183 A ,B 444983 A	25-04-1986 15-09-1985
DE 3710602	A	12-11-1987	HU CH DE FR IT YU	197681 B 672441 A5 3710602 A1 2600913 A1 1207523 B 66787 A1	29-05-1989 30-11-1989 12-11-1987 08-01-1988 25-05-1989 30-04-1990
US 5114079	A	19-05-1992	AT AU AU CA DE DE EP JP WO US	162959 T 651860 B2 9095191 A 2097909 A1 69128891 D1 69128891 T2 0561932 A1 6503260 T 9210296 A1 5192028 A	15-02-1998 04-08-1994 08-07-1992 11-06-1992 12-03-1998 28-05-1998 29-09-1993 14-04-1994 25-06-1992 09-03-1993
CH 271100	A	15-10-1950	NONE		
US 2108655	A	15-02-1938	NONE		
US 5250313	A	05-10-1993	US US US	4365546 A 4189503 A 4301183 A	28-12-1982 19-02-1980 17-11-1981